(12)

Patent Abstracts of Japan

PUBLICATION NUMBER : 62273821
PUBLICATION DATE : 27-11-87

APPLICATION DATE : 22-05-86
APPLICATION NUMBER : 61118960

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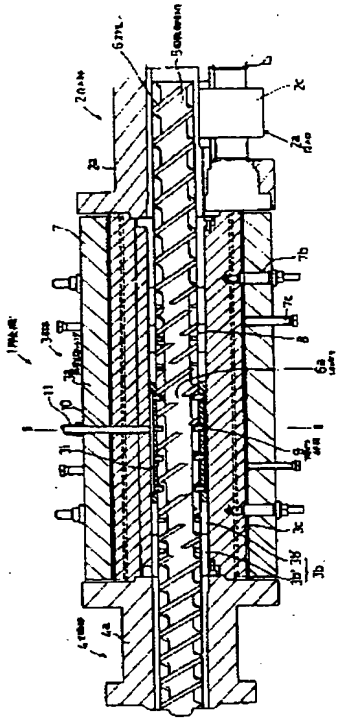
INT.CL. : B29C 47/76 // B29K 21:00

TITLE : METHOD AND APPARATUS FOR REMOVING GASEOUS AND WATER CONTENTS IN VISCOSE MATERIAL IN SCREW EXTRUDER



ABSTRACT : PURPOSE: To remove by discharging efficiently water contents out of an apparatus, by pressurizing or heating a viscose material in a kneading area to make temperature higher than ordinary and make inner water contents in easily evaporating state, and then by stopping the pressurization and heating, and by removing by sucking gaseous contents in the material.

CONSTITUTION: A rubbery material led in an introducing part 2 is applied by forwarding thrust and simultaneously pressurized to raise its temperature at a kneading area where the pitches of a screw 6 are small. Then the rubbery material fed into an apparatus itself 3 is forwarded with received thrust in spiral direction by the screw 6 and mixing effect is improved by contacting with a protruding part 8b of a pin member 8 which protrudes inside. After passing the kneading area, the pitches of the screw 6 become larger to relieve pressurization and also gaseous contents are sucked from a suction hole 9' of a hollow bottle member 9 for suction at downstream side where gaseous contents have a tendency of retention. At the same time because the boiling point of water contents is lowered owing to the lowering of pressure at the surroundings, water contents in the rubbery material are evaporated and gasified, and removed by being discharged outside from the suction hole 9'.

(19) Japanese Patent Office

(11) Publication Number
62-273821 (273821-1987)

(12) THE LAID-OPEN PATENT GAZETTE (A)

(51)Int.Cl.[4]	Identification code	Office File Numbers	(43) Publication date	27th Nov. 1987
B29C 47/76		6660-4F		
//B29K 21:00		4F		

Request for Examination Received

Number of Inventions 2 (Total 7 sheets)

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(54) Title of the invention: Method and device for removing gas component and water component from within a viscous material in a screw extruder

(21) Application number: 61-118960 (118960-1986)

(22) Application date: 22nd May 1986

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Specification

1. Title of the Invention

A method and a device for removing gas component and water component from within a viscous material in a screw extruder

2. Scope of Claims

(1) A method for removing gas component and water component from within a rubber material in a screw extruder which is characterized in that, in a screw extruder where a viscous material supplied from a rear material loading port in the screw extruder is mixed while being conveyed in the forwards direction by screw rotation so that it is extruded from a front end die, the temperature of the viscous material is raised by the pressurizing or heating of the viscous material in the material kneading region and then, by sucking out the gas component in the viscous material by means of hollow pin members used for suction placed within the rubber material conveyance passageway with the suction holes facing towards the downstream side of the material flow, the internal pressure within the extruder main body is lowered, so that the boiling point of the water component contained in the viscous material is reduced and vaporization effected, and the vaporized gas component is removed by the suction from the suction holes of the said hollow pin members.

(2) A device for removing gas component and water component from within a rubber material in a screw extruder which is characterized in that a screw shaft having a screw in the lengthwise direction of the

rotating shaft member is arranged in a freely rotating fashion within the cylindrical casing of the screw extruder main body, and the pitch of the screw is either narrowed at an intermediate position along said screw shaft or the diameter of the rotating shaft member is broadened so that the viscous material is pressurized, and a plurality of hollow pin members employed for suction which project into the viscous material passageway from the inner circumferential face of the aforesaid cylindrical casing to the rear of the pressurized region are spaced in the circumferential direction and the axial direction with the suction holes provided at the tips of the hollow pin members facing the downstream side of the viscous material flow and, moreover, notches are provided in the screw through which the projecting portions of the hollow pin members can pass, and the base ends of these hollow pin members are connected to a suction device via a connecting pipe.

3. Detailed Description of the Invention

(Industrial Field of Application)

The present invention relates to a method and to a device for removing the gas component and water component in a viscous material being conveyed by a screw in a screw extruder employed for the mixing, homogenization and extrusion of natural rubber, synthetic rubber or other such rubber material, or of a synthetic resin material (hereinafter these are merely referred to as the viscous material).

(Prior-Art)

When vulcanizing a kneaded viscous material, if there is a high gas component or moisture component content in the viscous material it is necessary to apply a considerable pressure to said viscous material in order to prevent the expansion of such components. Hence, the viscous material is introduced into a screw extruder and, while being conveyed by the screw, elimination of the gas component and moisture component contained in the viscous material is firstly carried out.

However, as shown in Figure 8, the method employed hitherto for removing gas component and moisture component in a viscous material has comprised providing, at a suitable position in the top face of the cylindrical casing **41** of the screw extruder, a through-hole **43** which connects within the viscous material passageway around screw **42**, and a suction device is connected to this through-hole **43** via a connection pipe, so that the gas component and moisture component in the viscous material are removed by suction from said through-hole **43**.

Consequently, in the aforesaid conventional method, it is only possible to eliminate gas component and water component present in the surface regions of the conveyed viscous material, so the percentage removal is low. Furthermore, if the suction force from the through-hole is too great, there is a fear that the viscous material itself will be sucked out, so there are limits to the suction force applied. Moreover, for similar reasons, the number of through-holes provided has at most been only one or two.

In recent years, an extrusion device has become more common where a screw rotating shaft is provided within the cylindrical casing in the kneading region of the device main body and a number of radial-direction pin members which project from the inner circumferential face of said cylindrical casing into the viscous material passageway are arranged spaced in the circumferential and axial directions and, furthermore, notches into which the projecting portions of the pin members can pass are introduced into the screw, and where construction is such that the pin members pass through the casing circumferential wall and the heating and cooling channel inside said casing (see JP-B-56-53500); and again more recently there has been proposed a structure where the aforesaid cylindrical casing is composed of a pin member embedding sleeve on the inner circumferential side and a casing main body on the outer circumferential side which is provided with a heating/cooling channel, and this pin member embedding sleeve and casing main body are each dividable at least into two in the circumferential direction, and there is provided in the region of the site of division of the casing main body a tightening mechanism which can integrally connect the divided sleeve and casing main body (Japanese Patent Application 61-76347). These are generally referred to as pin extruders.

(Problem to be Resolved by the Invention)

However, in the case of each of the aforesaid pin extruders, when compared to ordinary screw extruders of the pin-free type, the internal face pressure is low, so the viscous material is extruded from the extruder with gas component and water component still contained

therein, and therefore a suitable means is demanded for resolving the problem of removing the gas component and water component in a viscous material in this type of pin extruder.

As well as answering this demand, the aim of the present invention is to provide a method and a device for removing the gas component and the water component from within a viscous material in a screw extruder where the percentage elimination of these components is extremely high when compared to the aforesaid conventional method for removing the gas and water components.

(Means for Resolving the Problem)

For the purposes of realizing this objective, the essence of the present invention lies in employing hollow pin members for suction which project into the viscous material conveyance passageway within the screw extruder and, utilizing the fact that gas tends to accumulate on the downstream side of the pin members of a pin extruder, that is to say the downstream side of the viscous material flow, the gas component is sucked out from suction holes in the hollow pin members which are made to face the downstream side and then said component is discharged from the extruder. Furthermore, in the viscous material kneading region, by raising the temperature of the viscous material more than normal by positive application of pressure or by heating, the water component in the viscous material is given a readily vaporizable state, and then said positive application of pressure or heating is ceased, and the pressure is reduced by sucking-out the gas component in the viscous material by means of a vacuum pump or the

like, thereby causing the boiling point of the water to be reduced, so that there is produced a state such that the water component in the viscous material is readily vaporized, and in this way there is highly efficient elimination thereof from the extruder.

(Action)

In accordance with the method or device of the present invention, the viscous material supplied from a rear loading port in the screw extruder is subjected to propulsion by the screw and is conveyed in the forwards direction, and at a stage when it has advanced a fixed distance the temperature of the viscous material is raised by applying pressure or by heating, after which suction is applied from within the viscous material by means of hollow pin members used for suction which have their suction holes facing the downstream side of the viscous material flow, so that the gas component in the viscous material is sucked out, thereby lowering the pressure in the casing and causing the boiling point of the water to be reduced, with the result that there is vaporization of the water component in the viscous material, and this vaporized gas component is sucked out from the suction holes, and thus the gas and water components contained in the viscous material are eliminated.

(Examples)

Below, embodiments of the present invention are explained in detail based on the drawings.

Figure 1 is an entire longitudinal sectional view of a pin extruder used for the kneading of rubber material or

the like. In the drawing, extruder **1** comprises the rubber material loading region **2**, the main body **3** which constitutes the chief region serving as the rubber material mixing region, and the front portion **4** where the rubber material is extruded into the head section (not illustrated).

The loading region **2**, the main body **3** and the front portion **4** are respectively provided with cylindrical casings **2a**, **3a**, **4a**, and these casings **2a**, **3a**, **4a** are connected together. A rotating shaft member **5** is provided in a freely rotating fashion within these casings **2a**, **3a**, **4a**. Around the rotating shaft member **5**, a screw **6** is provided projecting along the entire length thereof but with the pitch of the screw **6** made rather smaller in the rubber material kneading region, so that at the same time as pressure is applied to the rubber material and its temperature raised there is produced a rubber material kneading action. Furthermore, circumferential direction notches **6a** are introduced in screw **6** within the main body **3**, at a specified spacing in the lengthwise direction. The casing **2a** in the loading region **2** is closed at its rear end and a rubber material loading port **2b** is provided in one side portion. The front end of the casing **4a** in the front portion **4** is open. At loading port **2b** there is arranged a feed device **2c**, and at the top of this a hopper is provided (not illustrated).

As shown in Figure 2, the casing **3a** of the main body **3** comprises a pin member embedding sleeve **3b** and a casing body **3c**, and both **3b** and **3c** are dividable into two in the circumferential direction. Pin member embedding

sleeve **3b** also divides in the lengthwise direction, forming a plurality of semicircular arc-shaped rings **3b'**.

In the interior of each of the divided casing bodies **3c'** there is provided a heating/cooling medium passage **3d** in the lengthwise direction, and at both edges of each divided casing body **3c'** there are provided projecting engaging portions **3e**. Further, at both sides of the engaging portions **3e** there are arranged tightening mechanisms **7** provided with a fitment groove **7a** into which fits the engaging portions **3e** in the state when divided casing bodies **3c'** are integrally connected together. A tightening screw member **7b** which passes through each tightening mechanism **7** and a separation screw member **7c** which is screwed onto mechanism **7** are mutually fitted in the lengthwise direction. One end portion of tightening screw member **7b** is screwed to underside aforesaid engaging portion **3e** and one end of separation screw member **7c** contacts underside engaging portion **3e**. Now, **3f** is the positioning member of pin member embedding sleeve **3b**, and it is fitted in positioning groove **3g** provided facing pin member embedding sleeve **3b** and casing body **3c**.

8 is a solid pin member, and pin members **8** are inserted into insertion holes **3h** provided in aforesaid semicircular arc shaped ring **3b'** passing through said ring **3b'** and facing the centre, and the projecting portions jut-out into the rubber material passageway in main body **3**.

As shown in Figure 3 and Figure 4, **9** is a hollow pin member used for suction of structure having a suction hole **9'** introduced in one direction of the side

circumferential wall, and suction hole **9'** of this hollow pin member is directed towards the downstream side of the rubber material flow. An annular groove **3i** is formed at the inner circumferential face of the aforesaid plurality of semicircular arc shaped rings **3b'** as shown in Figure 2 and, furthermore, there are provided a plurality of spaced suction holes **3j** which connect with annular groove **3i** from the outer circumferential face of semicircular arc ring **3b'**, and secured in suction holes **3j**.[i] Now, each aforesaid pin member **8** and hollow pin member **9** is arranged such that the projecting portion **8b** thereof comes inside a circumferential direction notch **6a** of screw **6**. Furthermore, there is provided a connecting hole **10** which runs from the outside face of one side of tightening mechanism **7** through the engaging portion **3e** of the upper side divided casing body **3c'** and the semicircular arc shaped ring **3b'** to connect with this annular groove **3i**. To the outside end of connecting hole **10** is fitted one end of connecting pipe **11** for connection to a suction device (not illustrated). The pitch of the screw **6** in the region where the hollow pin members **9** are arranged is made much greater than the pitch of the screw **6** in the aforesaid kneading region so that the compression action which acts on the rubber material becomes as small as possible.

Next, the mode of use is explained for the embodiment with the above construction.

In Figure 1, the rubber material led into loading region **2** from loading port **2b** is conveyed by means of screw **6** through the rubber material passageway into the main body **3** of the device, but since the pitch of the screw **6**

is considerably smaller in the kneading region, at the same time as applying a thrust in the forwards direction the temperature is raised due to the pressure applied to the rubber material. The rubber material which is conveyed inside main body **3** is subjected to a spiral thrust due to screw **6** and is made to advance. By contact with the projecting portions **8b** of pin members **8** which project inwards, the mixing action is promoted. In this way, the rubber material is conveyed forwards within the main body **3** but after the rubber material has passed through the kneading region, the pitch of screw **6** increases and, as well as the compression easing, the gas component in the rubber material (chiefly air) is sucked-out by the suction holes **9'** of the hollow pin members **9** used for suction. At the same time, the surrounding pressure falls and the boiling point of the water component is lowered, so the water component in the rubber material is vaporized and this vaporized water component is discharged outside from suction holes **9'**. When the rubber material is conveyed within main body **3**, there is contact with pin members **8** or hollow pin members **9** but, as mentioned above, the gas component tends to accumulate on the opposite side from the face of contact with the pin members **8** and **9**, that is to say on the downstream side of the conveyed flow of rubber material, so the gas component and the water component in the rubber material are efficiently sucked out from the suction holes **9'** of hollow pin members **9**.

The rubber material, in the state with the greater part of the gas and water components having been removed, is then carried further forward from the forwards direction front portion **4** to the head region, where extrusion from

an opening (a die) is carried out in a desired cross-sectional shape.

In the aforesaid embodiment, the pitch of screw **6** is made considerably smaller and pressure applied to the rubber material so that the temperature of the rubber material conveyed within screw extruder **1** is raised, but instead of varying the pitch of screw **6** the same effect may also be obtained by gradually increasing the outer diameter of rotating shaft member **5**, or by increasing the number of hollow pins **8** provided in this region. Again, instead of positively applying pressure to the rubber material, the rubber material may also be heated by arranging a heating means around the cylindrical casing **4** *{sic}* of main body **3** or by introducing a heating medium through aforementioned heating/cooling medium channel **3d**.

Figure 5 is a sectional view of the main feature of an embodiment in the case where the present invention is applied to the pin extruder described in aforesaid JP-B-56-53500. In this figure, **21** is the casing main body, and a plurality of pin members **23** project from main body **21** towards screw **22** on the inside. A suction hole **24** is opened at the tip of these pin members **23**, and a connecting hole **25** is provided from the base end face of pin member **23** to connect with suction hole **24**. Furthermore, pipes (not illustrated) connect the base ends of the connecting holes **25** in pin members **23** with a vacuum pump, so that the gas component within casing main body **21** is discharged from the device. In the figure, **26** is the channel for the heating/cooling medium.

Figure 6 and Figure 7 show still another embodiment of the present invention. The point of difference from the above embodiments lies in the fact that hollow pin member **9** is integrally connected to the pin member embedding ring **3b'**. Although illustration has been omitted, implementation is possible in the same way for solid pin members **8**.

(Effects)

As explained above, since the method and the device for removing gas and water components from a viscous material in a screw extruder according to the present invention have the aforesaid construction, there are the following effects.

(1) The gas component and water component in a viscous material can be sucked out from the interior and not just from the surface, so the percentage removal is high and the efficiency is good, and it is possible therefore to lower the pressure in the viscous material vulcanization stage. In particular, this is effective where there is used a screw extruder and successive vulcanization equipment in combination.

(2) In the case of a conventional pin extruder, there is a tendency for extrusion to be carried out in a state where the viscous material still has a high content of gas and water component and, furthermore, there is a tendency for gas component in the viscous material to accumulate on the downstream side of the pin members. However, in the present invention, the gas component and the water component in the viscous material are sucked out via hollow pin members provided with suction holes

on the downstream side of the pins, so the gas component and water component in the viscous material can be sucked out highly efficiently, and it is possible to reliably resolve the aforedescribed problems in a conventional pin extruder.

4. Brief Explanation of the Drawings

Figure 1 is an entire longitudinal sectional view of an embodiment of the present invention; Figure 2 is the section through line II-II in Figure 1; Figure 3(a) is a plan view of a hollow pin member and Figure 3(b) is a side section; Figure 4(a) is a plan view showing another embodiment of the hollow pin member and Figure 4(b) is a side section; Figure 5 is a sectional view of the chief part of another embodiment; Figure 6 is a sectional view of the chief part of still another embodiment; Figure 7 is a view of the left side face of same; and Figure 8 is an entire schematic view of an extruder equipped with a conventional gas removal means.

3 … extruder main body, 3a … cylindrical casing, 3b … pin member embedding sleeve, 3c … casing body, 5 … rotating shaft member, 6 … screw, 6a … notch, 7 … tightening mechanism, 8 … solid pin member, 9 … hollow pin member used for suction, 9' … suction hole, 10 … connection hole, 11 … connecting pipe

Agent for the Applicant Patent Attorney Y. Tsunoda

Figure 1

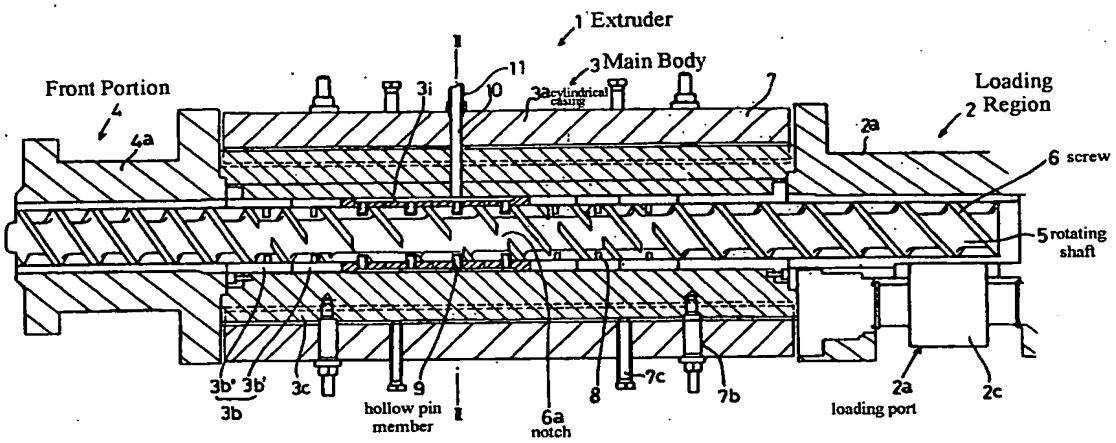

1 Extruder
3 Main Body
Front Portion
4
4a
3i
11
10
3a
cylindrical casing
Loading
2 Region
2a
6 screw
5 rotating shaft
3b' 3b'
3b
3c
9
hollow pin member
6a
notch
8
7c
7b
2a
loading port
2c

Figure 2

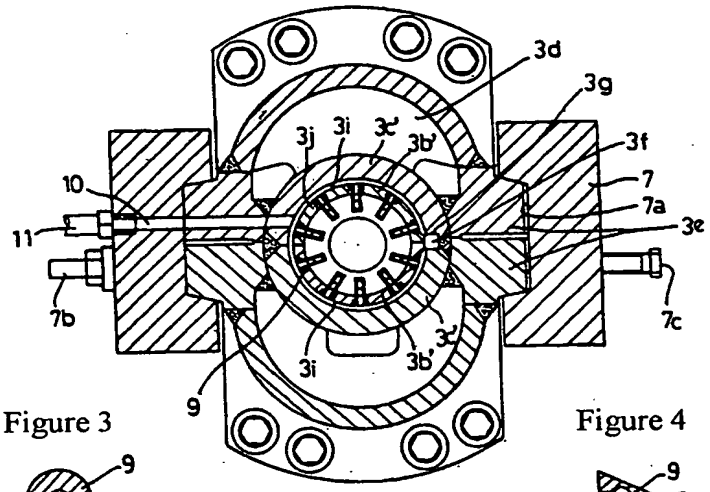


Figure 3

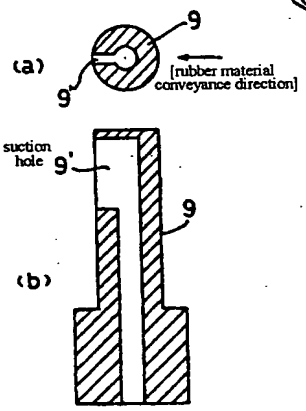


Figure 4

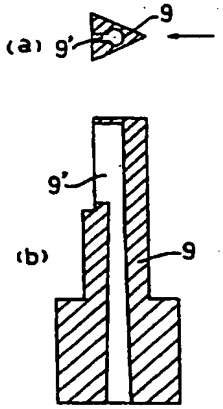


Figure 5

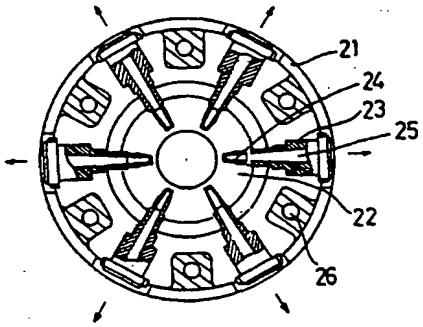


Figure 6

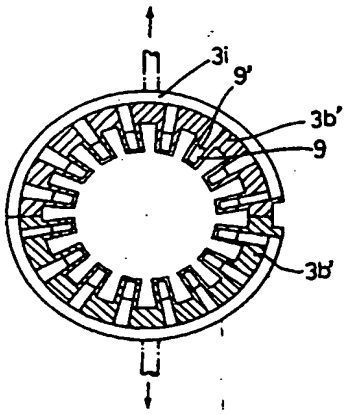


Figure 7

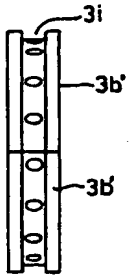
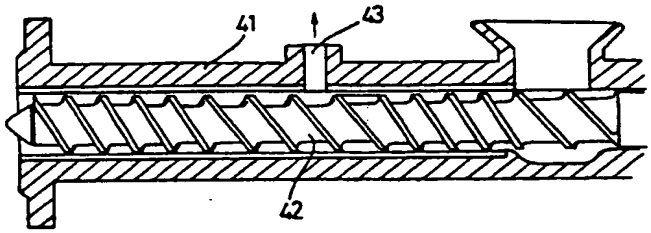


Figure 8



Translator's note

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[i] The Japanese text is unclear here as to what is being secured in suction hole **3j** (nor is this any clearer from the drawings).